WHAT IS CLAIMED IS:

1. A method for determining a composition of a dielectric layer on a semiconductor substrate, the method comprising:

monitoring a voltage across the dielectric layer under conditions where substantial leakage current flows across the dielectric layer;

determining a leakage voltage for the dielectric layer from the monitored voltage; and

determining the composition of the dielectric layer by comparing the leakage voltage to a reference voltage corresponding to the leakage voltage of a dielectric layer of known composition.

2. The method of claim 1, wherein the conditions where substantial leakage current flows across the dielectric layer are achieved by depositing an electric charge on a surface of the dielectric layer using a corona discharge.

3. The method of claim 2, wherein the voltage across the dielectric layer is monitored using a vibrating probe placed in proximity to the surface of the dielectric layer.

4. The method of claim 1, wherein the dielectric layer comprises first and second component materials, and the voltage across the dielectric layer is monitored for a polarity at which current-voltage characteristics for the first and second component materials differ the most.

5. A method for determining a composition of a test dielectric layer on a semiconductor substrate, the method comprising:

measuring a leakage voltage, V_T, at a first polarity for the test dielectric layer;

comparing V_T to a reference leakage voltage, V_R, corresponding to a leakage voltage at the first polarity for a reference dielectric layer having the same thickness as the test dielectric layer, wherein the reference dielectric layer comprises substantially none of a first material; and

determining a value, X_T, indicative of a concentration of the first material in the test dielectric layer based on a relationship between V_T and V_R.

6. The method of claim 5, further comprising determining the thickness of the test dielectric layer.

7. The method of claim 6, further comprising determining the reference leakage voltage from the thickness of the test dielectric layer.

8. The method of claim 7, wherein determining the thickness of the test dielectric layer comprises measuring a leakage voltage, V_{T2}, at a second polarity opposite the first polarity, proportional to the test dielectric layer thickness.

9. The method of claim 8, wherein the thickness of the test dielectric layer, T, is determined according to the equation

$$T = (V_{T2} - B_{R2})/A_{R2},$$

wherein B_{R2} and A_{R2} are predetermined parameters relating a reference leakage voltage, V_{R2}, corresponding to a leakage voltage at the second polarity for a reference dielectric layer comprising substantially none of the first material to a thickness of the reference dielectric layer, T_R.

10. The method of claim 9, wherein $V_{R2} = A_{R2} \times T_R + B_{R2}$.

11. The method of claim 5, wherein the reference dielectric layer comprises reference dielectric material having a conduction band energy, E_R^C, and a valence band energy, E_R^V, and the first material has a conduction band energy, E_T^C, and a valence band energy, E_T^V, and wherein measuring V_T comprises selecting the first polarity based on E_R^C, E_R^V, E_T^C, and E_T^V.

12. The method of claim 11, wherein the first polarity is negative when

$$|E_R^C - E_T^C| < |E_R^V - E^{TV}|.$$

13. The method of claim 11, wherein the first polarity is positive when

$$|E_R^C - E_T^C| > |E_R^V - E_T^V|.$$

14. The method of claim 5, wherein measuring V_T comprises:

depositing an ionic charge having the first polarity onto a surface of the test dielectric layer in an amount sufficient to cause a measurable leakage current to flow across the test dielectric layer;

monitoring a voltage of the dielectric layer after depositing the ionic charge; and

determining V_T based on the monitored voltage.

15. The method of claim 5, wherein X_T is proportional to a difference between V_T and V_R.

16. The method of claim 15, wherein X_T is determined according to the formula

$$X_T = (V_T - V_R) / (V_{T2} - B_{R2}),$$

wherein V_{T2} is a leakage voltage of the test dielectric layer at a second polarity opposite the first polarity and B_{R2} is a predetermined parameter relating a reference leakage voltage, V_{R2}, corresponding to a leakage voltage at the second polarity for a reference dielectric layer comprising substantially none of the first material to a thickness of the reference dielectric layer, T_R.

17. The method of claim 5, further comprising calculating the concentration, [X], of the first material in the test dielectric layer from X_T.

18. The method of claim 17, wherein [X] is calculated according to the formula

$$[X] = C_{CAL} \times X_T + D_{CAL},$$

wherein C_{CAL} and D_{CAL} are predetermined parameters relating [X] to X_T.

19. The method of claim 5, wherein the first material comprises nitrogen.

20. The method of claim 19, wherein the reference dielectric layer comprises SiO_2.

21. A method for determining a composition of a test dielectric layer on a semiconductor substrate, the method comprising:

depositing an ionic charge of a first polarity onto a surface of the dielectric layer using a corona discharge;

monitoring a voltage of the dielectric layer with a non-contact probe after depositing the ionic charge;

determining a leakage voltage, V_T, for the test dielectric layer based on the monitored voltage; and

calculating a value, X_T, indicative of a concentration of a first material in the test dielectric layer based on a difference between V_T and a reference leakage voltage, V_R.

22. The method of claim 21, wherein V_R corresponds to a leakage voltage at the first polarity for a reference dielectric layer having the same thickness as the test dielectric layer, wherein the reference dielectric layer comprises substantially none of the first material.

23. The method of claim 21, wherein calculating X_T comprises first determining V_R from a thickness of the test dielectric layer.

24. The method of claim 23, wherein the thickness of the test dielectric layer is determined by measuring a leakage voltage, V_{T2}, of the test dielectric layer for a second polarity opposite the first polarity, and calculating the thickness of the test dielectric layer using a function relating the thickness of a dielectric layer to its leakage voltage for the second polarity.